

NatureWorks® PLA Film Technical Bulletin

PRINTING AND LAMINATING

The printing of film for use in flexible packaging is one of the single most important secondary converting processes in today's market place. Printing is no longer just used to communicate what is in a package. It is the key to a brand owner for catching a consumer's attention, attracting them to the package, and differentiating their product from competitive products.

Understanding the fundamentals of the printing process and which ink system should be used is the key to the success in using biaxially oriented polylactide (BOPLA) film in a flexible packaging application. There are many different printing ink systems, chemistries, and printing methods available to the converter. Some of the most common inks used in printing flexible packaging are water based, solvent based, UV curable, and electron beam curable. There several different printing processes that use these ink systems and they include flexographic, rotary screen, and rotogravure printing. To better understand the aspects of these printing methods and how they can be used in printing flexible packaging, it is recommended that an ink supplier and or a printing machine manufacturer be consulted.

The appearance of the final product will also place specific demands on the choice of ink system or printing process. Questions about the packaging application to consider are:

- Is the film to be surface or reverse printed?
- Is an over print varnish required?
- Will cold seal be applied?
- What is the use condition of the package?
- What is the shelf life?

Processing parameters such as drying oven conditions, web tension, line speed and surface energy are equally critical to the success of printing a packaging film. Several of these parameters have been discussed previously in other NatureWorks, LLC technical bulletins.

Printing ink chemistry and determining which inks will adhere to BOPLA film is critical to printing success. Ink suppliers should be consulted during this process as a resource because of their vast experience in selecting and screening ink technologies. They can also provide a means to test a particular ink system before going to a full-scale print test. Table 1 shows some ink systems that have been tested and have good adhesion to BOPLA film.

Table 1.

Ink	Supplier	Chemistry	Use	Print method
Hydrokett 3000	Akzo Nobel	WB-acrylic	Surface and reverse print	Flexo
Hydrofilm 4000	Akzo Nobel	WB-acrylic	Surface and reverse print	Flexo
Polygloss	Flint Ink	SB	Surface print	Flexo and Rotogravure
Pyroflex	Sun Chemical	SB-nitrocellulose	Surface print	Roto
NuLam	Sun Chemical	SB-polyamide	Reverse print/lamination	Flexo and Rotogravure
UVAROLID	Zeller&Gmelin	UV-acrylate	Surface print	Indirect offset

SB – solventbased
WB – waterbased

Film lamination is equally important as printing in flexible packaging design and use. Laminating two or more substrates together to get enhanced performance from a flexible package is routine in today's market. There are many questions to be answered when constructing a flexible package. Does the packaging application require two or more films be laminated together? If so, what are the films, how are they alike, how are they different, and what method of lamination can be used? These and many other questions will need to be answered before taking the job to a production scale.

There are several different methods of laminating two or more packaging films together to produce a functional package. Films can be dry bond adhesive laminated, solventless adhesive laminated, extrusion laminated and in the case of a paper/plastic film lamination, wet bond laminated. Wet bond laminating involves applying water or solvent based adhesive to a plastic film and nipping the paper web to the plastic film before drying the adhesive. Following the nipping process the lamination goes through a drying oven to remove the water or solvent from the adhesive and the paper.

Extrusion laminating involves the use of a thermoplastic resin that is extruded onto a web as it passes through a nip area. This process often uses polyethylene resin as the thermoplastic adhesive and occasionally primers previously coated onto the films to improve adhesion.

Dry bond laminating involves applying an adhesive to the film and drying the adhesive in an oven prior to hot nipping with another film to form the laminated structure. The adhesives for this can be based on a variety of polymers and can be either water or solvent based.

Finally, solventless laminating involves applying a two component adhesive to a plastic film and nipping another film to form the lamination. The lamination is bonded together over time as the adhesive chemically reacts to form a thermoset cross-linked polymer. A variation of this laminating method is to apply a single component adhesive, which either cures through exposure to moisture or by the use of UV lamps or electron beam emitting devices.

Table 2 below outlines lamination results for BOPLA lamination structures. While this is by no means a complete list of the available technologies and products, it does provide the converter a starting point for product development. The lamination methods used were dry bond, wet bond and solventless laminating and are noted in the data table. It has been found that there are a variety of adhesive chemistries that bond BOPLA to itself or other plastic packaging films. To be considered a good lamination bond, the peel strength should be at least 350 grams per 25.4 mm width peel with the ideal peel strength strong enough to destruct either of the plastic packaging films comprising the lamination. The peel strength was measured on an MTS unit following ASTM [Need and number here?](#)

Table 2.

<i>Adhesive Type</i>	<i>Adhesive Product Number</i>	<i>Tg (C)</i>	<i>PLA Adhesion Rating</i>	<i>Lamination Structure</i>	<i>Peel Strength</i>	<i>Supplier</i>
Solventless	WD-4120/4122	0.5	1	PLA/foil	186g	H.B. Fuller Company
Solventless	WD-4120/4122	0.5	1	PLA/LDPE	26g	H.B. Fuller Company
Solventless	WD-4120/4122	0.5	1	PLA/PLA	27g	H.B. Fuller Company
Waterbased	PN-3759-ZX	-33.78	1	PLA/PLA	<50g	H.B. Fuller Company
Waterbased	PD-8156-H	9.13	1			H.B. Fuller Company
Waterbased	WD-4047	30	1			H.B. Fuller Company
Waterbased	WD-4009	40 mp	1			H.B. Fuller Company
Waterbased	WD-4051		1			H.B. Fuller Company
Solventless	WD-4110A/B	-11.53	5	PLA/foil	331g	H.B. Fuller Company
Solventless	WD-4110A/B	-11.53	5	PLA/LDPE	323g	H.B. Fuller Company
Solventless	WD-4110A/B	-11.53	5	PLA/PLA	191g	H.B. Fuller Company
Waterbased	WD-4006	-24.98	5	PET/PLA	399g	H.B. Fuller Company
Waterbased	WD-4006	-24.98	10	PLA/PLA	550g	H.B. Fuller Company
Waterbased	WD-4006	-24.98	10	PLA/LDPE	destruct	H.B. Fuller Company
Waterbased	56-0999	-15.82	10	PLA/20lb paper	fiber tear	Henkel Adhesives
Waterbased	56-5128	-13.1	10	PLA/20lb paper	fiber tear	Henkel Adhesives
Waterbased	56-5130	-8.27	10	PLA/20lb paper	fiber tear	Henkel Adhesives

Solventless	Tycol 7975/7276		1	PLA/LDPE	16g	Liofol Company
Solventless	Tycol 7650/9876		1	PLA/LDPE	23g	Liofol Company
Waterbased	8140A		1	PLA/LDPE	88g	Liofol Company
Solventbased	Tycol 7966/7287		10	PLA/LDPE	1282g	Liofol Company
Solventbased	Tycol 7966/7283		10	PLA/LDPE	1550g	Liofol Company
Waterbased	22378B NWC	-4.11	5	PLA/20lb paper	fiber tear	Northwest Coatings
Waterbased	20084B NWC	-46	7	PLA/20lb paper	fiber tear	Northwest Coatings

Adhesion Ratings

1=Poor

5=Good

10=Excellent

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www.aninks.com

Flint Ink
2433 Progress Court
Neenah, WI 54956
www.flintink.com

Zeller & Gmelin Printing Inks
3385 Highland Pine Drive
Duluth, GA 30096
(800) 848-8465
www.zeller-gmelin.com

H.B. Fuller Company
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(651) 236-3173
www.hbfuller.com

Henkel Technologies-Industrial Adhesives
1345 Gasket Drive
Elgin, IL 60120
(908) 962-1569
www.industrial-adhesives.com

Liofol Company
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Cary, NC 27511-6447
(919) 319-1933
www.lord.com

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7221 South 13th Street
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Safety and Handling Considerations

Material Safety Data (MSD) sheets for PLA polymers are available from NatureWorks LLC. MSD sheets are provided to help customers satisfy their own handling, safety, and disposal needs, and those that may be required by locally applicable health and safety regulations, such as OSHA (U.S.A.), MAK (Germany), or WHMIS (Canada). MSD sheets are updated regularly; therefore, please request and review the most current MSD sheets before handling or using any product.

The following comments apply only to PLA polymers; additives and processing aids used in fabrication and other materials used in finishing steps have their own safe-use profile and must be investigated separately.

Hazards and Handling Precautions

PLA polymers have a very low degree of toxicity and, under normal conditions of use, should pose no unusual problems from incidental ingestion, or eye and skin contact. However, caution is advised when handling, storing, using, or disposing of these resins, and good housekeeping and controlling of dusts are necessary for safe handling of product. Workers should be protected from the possibility of contact with molten resin during fabrication. Handling and fabrication of resins can result in the generation of vapors and dusts that may cause irritation to eyes and the upper respiratory tract. In dusty atmospheres, use an approved dust respirator. Pellets or beads may present a slipping hazard. Good general

ventilation of the polymer processing area is recommended. At temperatures exceeding the polymer melt temperature (typically 170°C), polymer can release fumes, which may contain fragments of the polymer, creating a potential to irritate eyes and mucous membranes. Good general ventilation should be sufficient

for most conditions. Local exhaust ventilation is recommended for melt operations. Use safety glasses if there is a potential for exposure to particles which could cause mechanical injury to the eye. If vapor exposure causes eye discomfort, use a full-face respirator. No other precautions other than clean, body-covering clothing should be needed for handling PLA polymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

Combustibility

PLA polymers will burn. Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. Do not permit dust to accumulate. Dust layers can be ignited by spontaneous combustion or other ignition sources. When suspended in air, dust can pose an explosion hazard. Firefighters should wear positive-pressure, self-contained breathing apparatuses and full protective equipment. Water or water fog is the preferred extinguishing medium. Foam, alcohol-resistant foam, carbon dioxide or dry chemicals may also be used. Soak thoroughly with water to cool and prevent re-ignition.

Disposal

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. For unused or uncontaminated material, the preferred options include recycling into the process or sending to an industrial composting facility, if available; otherwise, send to an

incinerator or other thermal destruction device. For used or contaminated material, the disposal options remain the same, although additional evaluation is required. (For example, in the U.S.A., see 40 CFR, Part 261, "Identification and Listing of Hazardous Waste.") All disposal methods must be in compliance with Federal, State/Provincial, and local laws and regulations.

Environmental Concerns

Generally speaking, lost pellets are not a problem in the environment except under unusual circumstances when they enter the marine environment. They are benign in terms of their physical environmental impact, but if ingested by waterfowl or aquatic life, they may mechanically cause adverse effects. Spills should be minimized, and they should be cleaned up when they happen. Plastics should not be discarded into the ocean or any other body of water.

Product Stewardship

NatureWorks LLC has a fundamental duty to all those that make and use our products, and for the environment in which we live. This duty is the basis for our Product Stewardship philosophy, by which we assess the health and environmental information on our products and their intended use, then take appropriate steps to protect the environment and the health of our employees and the public.

Customer Notice

NatureWorks LLC encourages its customers and potential users of its products to review their applications for such products from the standpoint of human health and environmental quality. To help ensure our products are not used in ways for which they were not intended or tested, our personnel will assist customers in dealing with ecological and product safety considerations. Your sales representative can arrange the proper contacts. NatureWorks LLC literature, including Material Safety Data sheets, should be consulted prior to the use of the company's products. These are available from your NatureWorks LLC representative.

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